Ultrasonic Scanning of Adhesively Bonded Plates.

1. Abstract

In many critical applications adhesively bonded materials are used and it is of importance to determine the state of the adhesive during service or aging. For instance, ultrasonic scanning of lap joints is the accepted way to scan for disbonds/corrosion on aircraft. It is also important to determine in many cases whether or not the adhesive is initially uniform and completely covering the area to be bonded. While ultrasonic imaging provides very good detectability for well adhered bonds, the bond quality can be difficult to detect in certain instances where the material is other than aluminum such as steel and the bonding agent is of low density such as certain epoxies. Ultrasonic imaging can be performed in a number of different modalities that might improve the contrast and detectability of the bond quality. Signal processing of the time domain waveforms to extract various features is possible with full waveform scanning and could further optimize the signal to noise ratio.

Project Outline

In this project we will use an ultrasonic imaging system to optimize contrast and hence detectability between adhesively bonded plates with a soft viscoelastic bonding layer. There are various ways to detect the adhesive, and these will be explored. A variety of 15 cm x 15 cm plates with an adhesively bonded layer will be made with various viscoelastic parameters that will also be used as a variable.

Unfocused and focused transducers will be used on the plates. Dual transducer scanning will be attempted and, if possible, a unique resonant scan of the plate will be compared to the pulse echo scans.

The parameters will be optimized experimentally with guidance from ultrasonic simulation tools. We will use Imagine 3D and Wave 2000 to simulate the experimental setup.

Timeline

Week 1. Lanl training and orientation, Literature search, equipment training
Week 2. Conventional scanning of plates, parameter optimization, Simulation training
Week 3. Scanning using dual probes, signal analysis, simulation
Week 4 Scanning using resonance technique, simulation
Week 5 Unconventional imaging using mode conversion
Week 6 Data analysis, repeat tests as needed
Week 7 Report writing starts
Week 8 Prepare presentation, complete paper and abstract for SPIE.

References:

J. David N. Cheeke, Fundamentals and Applications of Ultrasonic Waves, P340-343. 2002.
R. B. Thompson, and D. O. Thompson, J Adhesion Sci. Technology. 5, 583,1991.
P. Cawley and T. Pialucha, Proc. IEEE Ultrasonic Symposium 1993, 729